REMARKS

Claims 1-22, 24-26 and 28-35 remain pending. In this regard, it is noted that the Examiner indicated that claim 26 would be allowable if rewritten into independent form. Accordingly, claim 26 has been presented in independent form. Applicants appreciate the Examiner's consideration of the Application.

The § 103 Rejections

The Examiner rejected claims 1-25 and 28-35 under 35 U.S.C. § 103(a) as being unpatentable over a doctoral thesis entitled FATE AND TOXICITY OF AIRCRAFT DEICING FLUID ADDITIVES THROUGH ANAEROBIC DIGESTION by Cynthia Lee Gruden as directed by Dr. Mark Hernandez (hereinafter, Gruden I) in view of another publication entitled METAL ADSORPTION BY ACTIVATED CARBON: EFFECT OF COMPLEXING LIGANDS, COMPETING ADSORBATES, IONIC STRENGTH, AND BACKGROUND ELECTROLYTE by Reed, et al. (hereinafter Reed). Applicants respectfully traverse, as will be discussed below. It is noted that the claims have been amended in a way which is thought to more distinctly claim and particularly point out that which Applicants regard as being inventive. Hence, the arguments below will address the prior art with respect to the claims, as amended above.

Initially considering claim 1, as amended, this claim now recites:

> [I]n a solution having a specific acidic pH and containing metal cations, adding (i) an amphipathic, heterocyclic, metal-coordinating compound that is selected based, at least in part, on a charge distribution which maintains a charge neutrality of the amphipathic, heterocyclic, metal-coordinating compound at said specific pH and (ii) a sorbent, such that the addition at the specific acidic pH causes at least some of the metal-coordinating compound to bind with some of the metal cations and at least some of the metal-coordinating compound to sorb to the sorbent, along with any metal cations bound therewith.

In attempting to meet the limitations of original claim 1, which continue to be embraced by the amended claim, the Examiner states that Gruden I discloses removing heavy metals from an industrial waste stream by adding methylbenzotriazole and granular activated carbon such that the methylbenzotriazole simultaneously binds the heavy metals and is adsorbed by the granular activated carbon. Applicants respectfully disagree with this characterization of Gruden I.

The Gruden I reference, when considered as a whole, is directed to environmental concerns with respect to the presence of methylbenzotriazole in the runoff from aircraft deicing fluid. A paper labeled "Exhibit A" and entitled ANAEROBIC DIGESTION OF AIRCRAFT DEICING FLUID WASTES: INTERACTIONS AND TOXICITY OF CORROSION INHIBITORS AND SURFACTANTS by Gruden et al (hereinafter Gruden II) is brought to the attention of the Examiner for purposes of understanding the framework of Gruden I, as well as what the reference fairly teaches, as a whole. For reasons which will be made apparent below, it is important to understand that Gruden II is addressed directly to the subject matter of the anaerobic digestion of aircraft deicing fluids.

Gruden II, on page 149, first column, states:

> In the United states, propylene glycol-based deicing fluids containing significant concentrations of special-purpose chemical additives are in widespread use. These additives reduce flammability, corrosion potential, and surface tension of glycol solutions for application to aircraft structures.

The specific additive that is used in these deicing fluids is methylbenzotriazole, per industry specification, as described by Gruden II. It is of interest to note that the propylene glycol flammability problem caused a tragic fire, resulting in the loss of the Apollo 1 spacecraft and its crew, providing a motivation to add methylbenzotriazole to deicing fluid. With respect to corrosion, benzotriazole is a well-known corrosion inhibitor and, as such, provides the further benefit of inhibiting corrosion reactions that occur when glycol solutions come into contact with metal components carrying direct current, as mentioned by Gruden II.

With the foregoing in mind, when the methylbenzotriazole containing deicing fluid is sprayed upon a metal airframe, the methylbenzotriazole "sticks" to the airframe and prevents corrosion, while serving as a flame retardant. The runoff contains propylene glycol, as well as methylbenzotriazole. It is important, in this regard, to understand that Gruden I is not concerned with metal contamination in this runoff. Methylbenzotriazole, in column 1, page 72, of the Gruden I reference, is recognized as complexing strongly with the metal of the aircraft frame in functioning as a well-known corrosion inhibitor, since that is the very reason for the presence of the methylbenzotriazole in the deicing fluid, in the first instance.

In rejecting original claim 1, the Examiner refers to page 123 of Gruden I. In particular, Applicants believe that the following passage is relied on:

> Current novel digester configurations (USAB) have incorporated GAC as a support matrix to retain high biomass levels. Results from this research indicate that the addition of GAC to an anaerobic treatment system for ADF waste may diminish the toxic effects of MeBT and may eliminate MeBT from the effluent. This design may be fortuitous for other industrial waste streams because MeBT sorbs to GAC while simultaneously binding heavy metals; thus, adding MeBT to PACT or USAB may enable the treatment of waste streams with very high metals content that would otherwise be toxic.

Although this passage states that MeBT sorbs to GAC while simultaneously binding heavy metals, the suggestion is made in the context of removing heavy metal in an anaerobic digester. An anaerobic digester is a microbiological system which must run at neutral pH to operate properly. Because of the microorganisms in anaerobic digesters, metals are highly toxic to these systems in very low concentrations. Thus, the comment is made in the context of attempting to protect the microorganisms of the digester from metals, not with respect to treating waste streams in general. In other words, the quote above is alluding to the subject matter of Gruden II, that is, anaerobic digesters. In view of the foregoing, the comment is necessarily inapplicable to an acidic pH, since anaerobic digesters can not operate at an acidic pH and, therefore, the comment can not apply to the method that is recited by amended claim 1 which requires an acidic solution.

Further, the Gruden I reference engages in conjecture by stating that the mechanism for removing MeBT from ADF effluent that is taught may enable the treatment of waste streams with very high metal content. In this respect, the reference provides no further examination of the mechanism or suggestions even as to how the mechanism could be explored, nor is any analysis presented with respect to the chemistry that is involved in removing a metal using methylbenzotriazole. It is considered that this naked suggestion falls considerably short of the standards that are required in order to make out a proper rejection under sections 102/103. In particular, each and every limitation must be set forth by the references in an essentially identical form by the reference and must be enabling, aside from the additional requirement to provide an objective teaching to combine the references in the suggested manner. Certainly, mere conjecture as to a technique that may work is insufficient. For all of these reasons, it is respectfully submitted that reliance on this reference is inappropriate and that the rejection should be withdrawn on this basis.

Further with respect to Gruden I, the Examiner admits, and Applicants agree, that this reference fails to teach the acidic pH that is recited by claim 1 and could not reasonably be taken as doing so, since an acidic pH would make Gruden I inoperable, as stated above. Accordingly, the Examiner attempts to modify Gruden I in view of Reed.

Reed is directed to removal of metal contamination, specifically testing cadmium and nickel over a range having a lower limit of pH 3. It is of interest to note that Reed includes a particular focus on electrostatic force (i.e., electrostatic immobilization). In this regard, the present application, in paragraph 168, notes a number of prior art studies that were directed to metal removal with citrate and with EDTA. Paragraph 168 concludes with the statement:

> These studies demonstrated that leveraging the sorptive properties of amphipathic chelating agents are dependent on optimizing conditions for the electrostatic immobilization of metal-organic and complexes. [emphasis supplied]

As will be discussed immediately below, Reed is considered to fall within the class of "electrostatic immobilization" techniques contemplated by the passage that is set forth immediately above. This is to be contrasted with the present invention, as claimed, namely the requirement for the sorption of an amphipathic compound while, at least approximately, maintaining charge neutrality, neither of which describe the character of EDTA under any physical-conditions, except that EDTA can be near charge neutral at extremely high pH (c.a. 11), a rare environmental or process treatment condition, in which case the heavy metals cited herein are poorly available for complexation with any known chelating agent because they form hydroxyl and carbonate complexes and precipitates. Indeed under the conditions observed by Reed, because EDTA is highly polar and not amphipathic, strong electrostatic forces are implicated as the mechanism governing metal sequestration from solution.

Reed discusses surface charge characteristics of activated carbons in water and presents an equation that includes an electrostatic component on page 1987. This mechanism is discussed on the same page, fourth paragraph. Electrostatic force is then brought into play in the Scenario 1 discussion on page 1988 of Reed which discusses the electric double layer of activated carbon, that is considered by Applicants as an obvious electrostatic characteristic. Page 1989 includes an extensive discussion of electrostatic force with respect to both Reed's Scenario 2 and Scenario 3. Further, on page 1989, the following paragraph is present:

> In addition to the electrostatic forces, the magnitude and sign of chemical interaction term will also be dependent upon pH. The effect this has on metal adsorption is more difficult to predict because the carbon's affinity for the metal, ligand, and metal-ligand complex has not been quantified. Further research on this topic is recommended.

This paragraph refers to the aforementioned equation, presented by Reed, wherein a first term represents chemical affinity and the second term represents electrostatic forces. It is clear that this passage essentially admits that the Reed paper is only directed to the study of electrostatic interaction and that other chemical mechanisms at play are not understood and have not been considered. Seen in this light, the Reed paper is clearly consistent with the studies mentioned in paragraph 168 of the present application that are directed to leveraging electrostatic immobilization, as will be further described.

In relying on Reed in making out the section 103 rejections, the Examiner has cited figures 7 and 8 of Reed, which encompass Scenario 2. The latter is introduced on page 1988, carrying over to page 1989. The experimental results are described starting at the bottom of page 1993 and carrying over to page 1996. The metal removal mechanism is attributed entirely to electrostatic attraction and, more particularly, to the use of a special carbon with a surface having a positive charge density below pH 10.4 in combination with the EDTA complexes of cadmium and nickel carrying a negative charge. Indeed in an acidic pH range, the carbon used by Reed with was intensely positively charged. Reed then, once again, appears to disclaim an understanding of any mechanism at play other than electrostatics. Clearly, electrostatic immobilization is being manipulated through the use of a very special carbon.

In view of the foregoing, it is clear that Reed is teaching an electrostatic metal removal mechanism. As will be discussed below, it is considered that Reed, standing on its own merits, bears little, if any, reasonable relationship to the limitations that are encompassed by claim 1, as amended.

With respect to claim 1, it is important to understand that an amphipathic heterocyclic metal-coordinating compound is recited. Moreover, claim 1 has been amended to further recite that the amphipathic, heterocyclic, metal-coordinating compound is selected based, at least in part, on a charge distribution which maintains a charge neutrality of the amphipathic, heterocyclic, metal-coordinating compound at said specific pH. In Reed, EDTA is essentially relied on for behaving in a way that is diametrically opposed to the physical/chemical architecture and behavior that claim 1 recites in maintaining an at least approximate charge neutrality at the specific acidic pH. At paragraph 85 of the specification, this behavior of the selected amphipathic heterocyclic metal-coordinating compound is characterized:

> As will be described further, unlike other most other binding compounds, these compounds are recognized by the present invention as being unlike any other binding compound. These compounds exhibit an appropriate charge distribution for enhancing immobilization of metal cations on activated carbon surfaces at a specific acidic pH. Specifically, the mechanism by which it is thought that these metal-coordinating compounds are able to operate in acidic pH ranges resides in their ability to maintain, or to maintain at least to an approximation, a charge neutral state in acidic ranges, while certain ones of these compounds are able to maintain

sufficient charge neutrality even in strongly acidic pH ranges such as, for example, extending below pH 2.

As is made clear by the foregoing passage, the recited compound maintains near charge neutrality in acidic pH ranges. Thus, the mechanism of removal is not based on the attraction of opposite electrostatic charges. Reed, in contrast and taken as a whole, specifically teaches the use of electrostatic attraction between carbon and a metal-ligand complex as a mechanism of removal. For these reasons, it is believed that Reed teaches away from the claimed combination, particularly in view of an apparent express disclaimer of any understanding of additional chemical mechanisms that may be at play. It is noted that, in order to make out a proper rejection under section 103, a reference must be taken for what it fairly teaches, as a whole. Seen in this light, it is submitted that Reed is taken out of context, based on an isolated disclosure which shows increased metal removal at an acidic pH, without considering the actual mechanism that is taught by the reference, as a whole. Accordingly, it is respectfully submitted that reliance on the Reed reference is inappropriate with respect to teaching better results using H-type carbon at an acidic pH, at least for the reason that the reference fails to teach, disclose or suggest the use of an amphiphatic, heterocyclic metal coordinating compound which maintains charge neutrality at the specific acidic pH nor any advantages associated therewith and recognized by Applicants, as discussed in further detail below and described in the specification. Accordingly, for at least these reasons, allowance of claim 1, as amended, is respectfully requested.

Still considering the rejection of claim 1 under section 103, it is well-settled that a rejection under section 103 must be supported by an objective teaching in the art of record to make the proposed modification or modifications. As described above, Gruden I describes the removal of methylbenzotriazole from aircraft deicing fluid. Further, there is no discussion, or experimental observation, in Gruden I with respect to an acidic environment nor is there a teaching in Gruden I with respect to the presence of any metal contamination in this run-off. Reed, on the other hand, teaches removal of metal contamination in an acidic environment using electrostatic charge with EDTA and a unique carbon that maintains a positive charge at negative pH. Thus, there are major mechanistic differences in Gruden I and a very major difference in Reed, as distinguished from the present invention, as recited in claim 1. For example, the Gruden I environment is defined by anaerobic microbiological activity and expressly not acidic for this reason, and there is absolutely no suggestion in Gruden I of an acidic environment. As another example, the use of EDTA by Reed to remove metal contaminants is an entirely different and clearly distinguishable approach as compared to the approach taken by Applicants, namely the use of an amphipathic, heterocyclic metal coordinating compound as recited by amended claim 1, discussed in the specification and in the present remarks. Moreover, the activated carbon must include the correct forced charge at low pH, in order to use the Reed technique. Applicants respectfully submit that there would be no motivation to make the proposed modifications of Gruden I in view of Reed, since Gruden I is not dealing with an acidic environment, but rather contains an unsupported suggestion in relation to anaerobic digesters. The two references are completely disparate in these respects. Modification of an anaerobic digester to process an acidic waste stream will result in a device that is inoperable for its intended purpose. Further, amphipathic, heterocyclic compounds do not partition on the basis of electrostatic attraction, but maintain charge neutrality in acidic environments, as described in paragraph 85 of the specification. Accordingly, for all of these reasons, it is respectfully submitted that claim 1, as amended, is allowable over the art of record.

Claims 2-22, 24 and 25 each depend either directly or indirectly from and therefore include the limitations of claim 1. Accordingly, it is respectfully submitted that each of these claims is also patentable over the art of record for at least the reasons set forth above with respect to claim 1. Further, each of these dependent claims places additional limitations on their parent and intermediate claims which, when considered in light of claim 1, further distinguish the claimed invention from the art of record.

For example, claim 3, as amended, recites that the metal-coordinating compound includes a binding portion containing a plurality of heteroatoms and a hydrophobic portion for hydrophobically sorbing to the sorbent. It is noted that this claim has been amended in a way which further emphasizes that the immobilization mechanism in use does not utilize electrostatic force. For at least this reason, allowance of claim 3 is respectfully requested.

As another example, claim 4 recites that the metal-coordinating compound is selected from the group consisting of a benzotriazole and a benzothiazole.

As still another example, claim 5 recites that the specific pH is in a range from approximately pH 2 to pH 6 and the metal-coordinating compound is Benzotriazole, Benzothiazole or Methylbenzotriazole. It is of interest to note that the Reed reference shows no data below pH 3. In this regard, it is suspected that the electrostatic immobilization technique taught by Reed is inoperable at such depressed pH levels at least for the reason that the selected H type carbon and metal-chelating EDTA will experience a markedly lesser attraction as EDTA interacts with protons and the positively charged state of the activated carbon increases with continued pH depression.

As a further example, claim 7 recites an extremely acidic environment in which the specific pH is less than approximately 2. Again, Reed shows no data below pH 3. Claim 8 depends from claim 7 and recites that the metal-coordinating compound is selected as at least one of carboxybenzotriazole, any fatty acid conjugated benzotriazole derivative, butylbenzotriazole, other aliphatic conjugated benzotriazole and benzothiazole. Claim 9 depends from claim 7 and requires that the sorbent is an acidic activated carbon. Claim 10, likewise depends from claim 7 and requires that the sorbent is an L type activated carbon. Reed specifically uses an H type activated carbon. Clearly, the art of record is devoid of any teaching with respect to operation below pH 2.

Claim 11 depends from claim 9 and recites that the metal-coordinating compound is at least one of benzotriazole and benzothiazole. Claim 12 depends from claim 11 and further requires that the sorbent is an acidic activated carbon. Claim 13 also depends from claim 11 and further requires that the sorbent is an L type activated carbon, as opposed to the use of an H type carbon in Reed. Again, the art of record is devoid of any teaching with respect to operation below pH 2.

Claim 16 recites removing from the solution the metal-coordinating compound sorbed to the sorbent and the metal cations bound with the sorbed metal-coordinating compound. Applicants are unable to find any reasonable teaching with respect to these limitations in the art of record.

Claim 17 recites that the metal cations bind the metal-coordinating compound by each metal ion coordinating with a plurality of heteroatoms of the metal-coordinating compound.

Claim 18 requires that adding includes forming a combination of the metal-coordinating compound sorbed to the sorbent and, thereafter, introducing the combination into the solution. Applicants respectfully submit that the art of record is devoid of this feature in any reasonable combination.

Claim 19 requires that adding includes separately introducing each of the metal-coordinating compound and the sorbent to the solution. Claim 20 further requires that the metal-coordinating compound is introduced before the sorbent is introduced. Applicants respectfully submit that the art of record is devoid of any reasonable suggestion of these features in any reasonable combination.

Claim 21 recites that the metal-coordinating compound includes a ring selected from the group consisting of a triazole ring and a thiazole ring and the metal cations bind with said ring.

Claim 22 recites that the solution is aqueous and adding includes selecting a compound from the group consisting of a benzotriazole and a benzothiazole as the metal-coordinating compound.

Claim 28 is an independent claim which recites introducing an amphipathic, heterocyclic metal-coordinating compound into the solution at the specific acidic pH, such that at least some of the metal cations bind with the binding compound. The solution is then exposed to a sorbent at the specific acidic pH, so that at least some of the metal-coordinating compound sorbs to the sorbent along with any metal cations bound therewith. Further, claim 28 has been amended to reflect the amendments made in claim 1. To the extent that these combined limitations reflect the limitations of amended claim 1, as discussed above, the arguments made with respect to the patentability of claim 1 over the art of record are equally applicable with respect to the patentability of amended claim 28. Accordingly for at least these reasons, allowance of claim 28, as amended, is respectfully requested.

Claim 29 depends directly from and therefore includes the limitations of claim 28. Accordingly, it is respectfully submitted that claim 29 is also patentable over the art of record for at least the reasons set forth above with respect to claim 28. Further, claim 29 places additional limitations on claim 28 which, when considered in its light, further distinguish the claimed invention from the art of record.

For example, claim 29 recites that exposing includes (i) enclosing the sorbent in a flow-through enclosure and (ii) causing the solution, including the metal-coordinating compound, to flow through the sorbent in the enclosure for sorbing the metal-coordinating compound and metal cations bound therewith. It is respectfully submitted that the art of record is devoid of this combination of features when viewed in any reasonable light.

Claim 30 is an independent claim which requires enclosing an amphipathic, heterocyclic metal-coordinating compound and a sorbent in a flow-through enclosure. The solution is caused to flow through the enclosure such that at least some of the metal cations bind with the binding compound at the specific acidic pH and at least some of the metal-coordinating compound sorbs to the sorbent at the specific acidic pH, in the enclosure, along with any metal cations bound therewith. Further, claim 30 has been amended to reflect the amendments made in claim 1. To the extent that these combined limitations reflect the limitations of amended claim 1, as discussed above, the arguments made with respect to the patentability of claim 1 over the art of record are equally applicable with respect to the patentability of

amended claim 30. Further, Applicants find no teaching in the art of record with respect to enclosing these specific materials in a flow-through enclosure. Accordingly for at least these reasons, allowance of claim 30, as amended, is respectfully requested.

Claims 31 and 32 each depend directly from and therefore include the limitations of claim 30. Accordingly, it is respectfully submitted that each of these claims is also patentable over the art of record for at least the reasons set forth above with respect to claim 30. Further, each of these dependent claims places additional limitations on their parent and intermediate claims which, when considered in light of claim 30, further distinguish the claimed invention from the art of record.

For example, claim 31 requires sorbing the metal-coordinating compound to the sorbent before enclosing the materials in the flow-through enclosure.

As another example, claim 32 recites equilibrating the metal-coordinating compound with the sorbent before enclosing.

Claim 33 is an independent claim which recites that (i) an amphipathic, heterocyclic, metal-coordinating compound and (ii) a sorbent, are added to a solution having a specific acidic pH and containing metal cations such that at least some of the metal-coordinating compound and at least some of the sorbent cooperate at the specific acidic pH to sequester at least some of the metal cations from the solution. Further, claim 33 has been amended to reflect the amendments made in claim 1. To the extent that these combined limitations reflect the limitations of claim 1, as discussed above, the arguments made with respect to the patentability of claim 1 over the art of record are equally applicable with respect to the patentability of amended claim 33. Accordingly for at least these reasons, allowance of claim 33, as amended, is respectfully requested.

The Examiner rejected Claim 34 under 35 U.S.C. § 103(a) as being unpatentable over an EPA publication entitled INVESTIGATION OF SELECTED POTENTIAL ENVIRONMENTAL CONTAMINANTS: BENZOTRIAZOLES (hereinafter, the EPA publication). Applicants respectfully traverse, in view of the amendments above and as will be discussed below.

In making out the rejection, the Examiner states that this reference discloses the claimed invention with the exception of the recited pH. And that since the reference fails to disclose any criticality for the pH of the wastewater, one would be motivated to use the disclosed method in a slightly acidic pH. Applicants respectfully disagree. Initially, it is noted that the reference teaches the use of a very large amount of benzene solvent (one volume per two volumes of wastewater) in combination with benzotriazole. Thus, it is submitted that the reference is teaching a completely different method. Further, the removal mechanism is not described and there is no reason to assume that the presence of the benzene is not critical to the process outcome. Moreover, the reference admits that the remaining benzene is problematic and offers no remedy. Accordingly, for these reasons standing on their own, it is submitted that claim 34 is allowable over the EPA publication.

Still considering the rejection of claim 34, it is important to understand that the wastewater being treated is at pH 7.85. In this regard, wastewater is generally neutral or better. Claim 34 has been amended in a way which is thought to particularly point out that metal cations are liberated into solution by the acidity thereof and that the metal cations are bound to an amphipathic, heterocyclic metal-coordinating compound. Such metal cations are not present in neutral or higher pH. Thus, whatever mechanism is at play in the EPA publication will most likely be inoperable at a pH that is sufficiently acidic to liberal metal cations. Hence, it is submitted that the EPA publication fails to teach, disclose or reasonably suggest the claimed combination. Accordingly, for at least these reasons, allowance of claim 34 is respectfully requested.

Claim 35 depends directly from and therefore includes the limitations of claim 34. Accordingly, it is respectfully submitted that claim 35 is also patentable over the art of record for at least the reasons set forth above with respect to claim 34. Further, claim 35 places additional limitations on claim 34 which, when considered in its light, further distinguish the claimed invention from the art of record.

For example, claim 35 recites sorbing at least some of the metal-coordinating compound and metal cations bound thereto using an activated carbon at the specific acidic pH. The reference contains no teaching with respect to the use of a sorbent and no discussion as to the effect that the large portion of benzene which remains.

For the foregoing reasons, it is respectfully submitted that all of the Examiner's objections have been overcome and that the application is in condition for allowance. Hence, allowance of these claims and passage to issue of the application are solicited.

If the Examiner has any questions concerning this case, the Examiner is respectfully requested to contact the undersigned at 303-410-9254.

Respectfully submitted,

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